Colors and *Shapes*

for the

Cryo-Shield

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HOW MANY PHOTONS HIT THE FOCAL PLANE

How many stars are there in the SNAP survey region?

35,000 Stars brighter than 18th Magnitude in a 15 square degree Survey region

What is the photon flux from these stars at the focal plane?

~600 million Photons/sec/square degree/micron filter bandpass

Focal plane is ~1.7 square degrees including unpopulated pixel areas

Filter bandpass ~ 0.1 micron

Photon Flux ~100 million Photons/sec

How many of these photons backscatter off of the shield and re-hit the focal plane?

Assume a uniform distribution of photons scattering back to the focal plane

Photon Flux ~100 million Photons/sec/2πsr

Divide by # of pixels in a fully populated focal plane (~3e9 pixels)

=0.03 photons/sec/2πsr/pixel (average)

Divide by 100 for the shield coating attenuation

= 3e-4 photons/sec/2πsr/pixel (average)

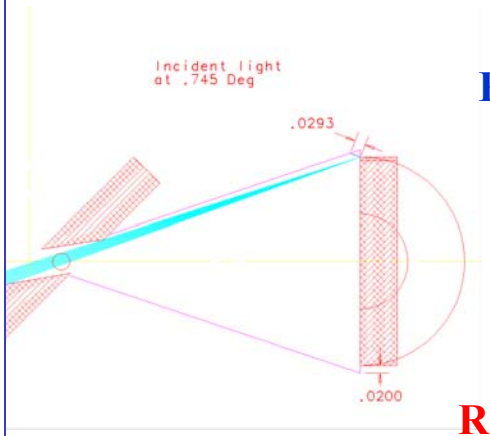
Divide by 2 since about half of the photons are pointed towards the focal plane

= 1.5e-4 photons/sec/pixel (average)

Zodiacal Background ~0.25 photons/sec/pixel (M. Sholl, Focal Plane Light Levels 2/04)

WORST CASE PHOTON FLUX AT THE FOCAL PLANE

Assume a Single Magnitude 8 Star hitting near the edge of the Focal Plane



Photon Rate at an Aperture

$R_p = 10^{11} * .7 * D^{2} * \Delta\lambda * 10^{-.4m}$ (Ref – D. Schroeder, Astronomical Optics)

10^{11} = # of photons/sec from a magnitude 0 star

.7 = transmission coeff.

D = 2 meter diameter mirror

$\Delta\lambda$ = 100 nm bandpass of filters

m = 8 for a magnitude 8 (max magnitude in Super Nova field)

$R_p \sim 20 \times 10^{6}$ photons/sec hitting the focal plane for an M8 star

How many of the photons back scatter to a small patch of pixels on the focal plane?

Multiply the photon flux by the number of steradians in

a 30x30 micron patch of pixels, 0.03 meters from the cone shield

Near side of the focal plane 20×10^{6} photons/sec * (30e-6/0.03)^2 = 20 photons/sec/pixel patch

Far side of the focal plane = 20×10^{6} photons/sec * (30e-6/0.6)^2 = 0.05 photons/sec/pixel patch

Assuming a Black Paint on the Shield, photon rate is reduced by ~ 0.01

Near Side = 2e-1 photons/sec/pixel patch

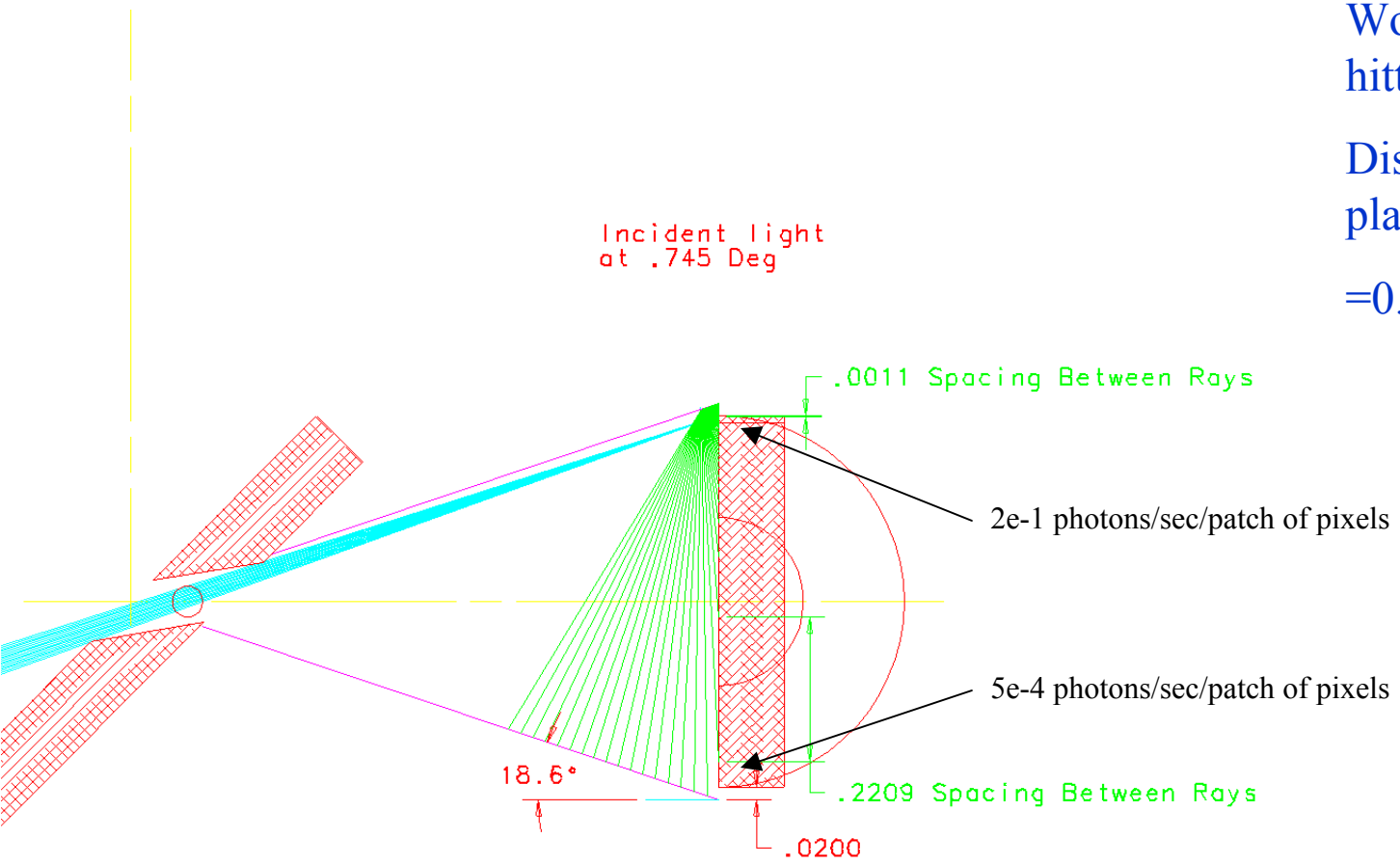
Far Side = 5e-4 photons/sec/pixel patch

Ray Tracing of Light Hitting Small Cone Shield

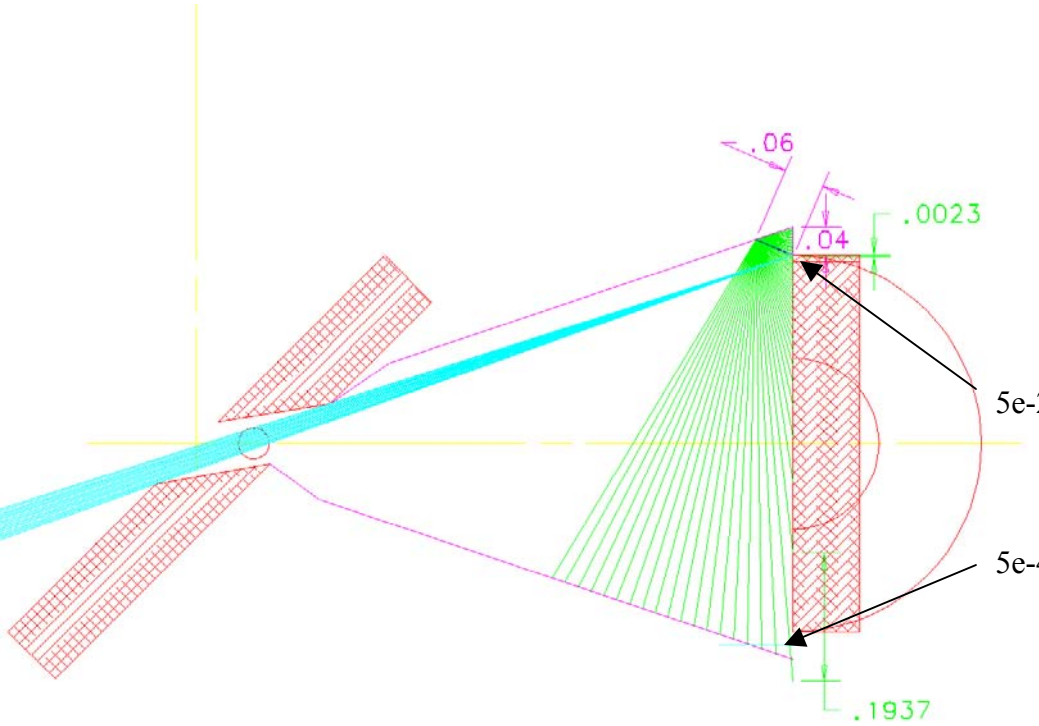
Worst case M8 star hitting near edge

Distance from focal plane to shield

=0.03 meters



Ray Tracing of Light Hitting Large Cone Shield



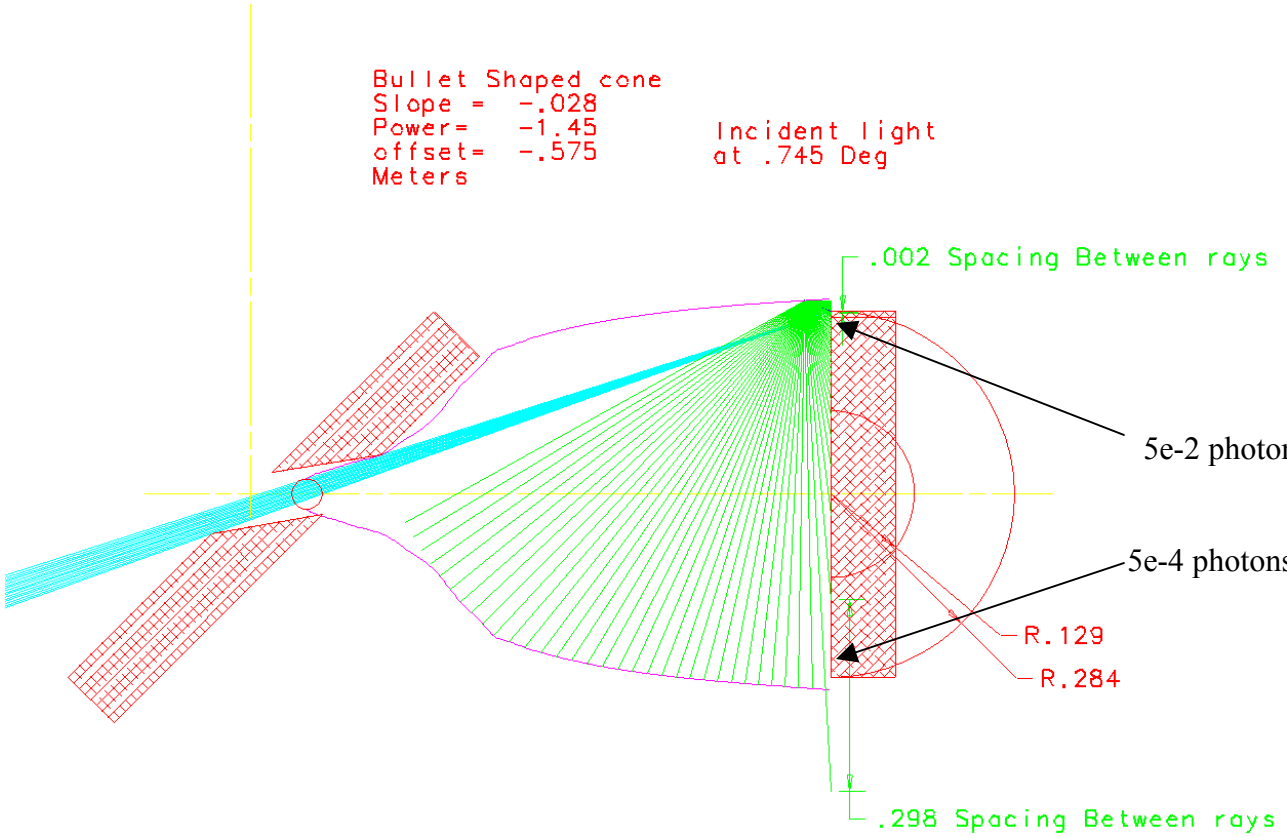
Worst case M8 star hitting near edge

Distance from focal plane to shield

=0.06 meters

4x less intensity than small cone

Ray Tracing of Light Hitting Bullet Shield



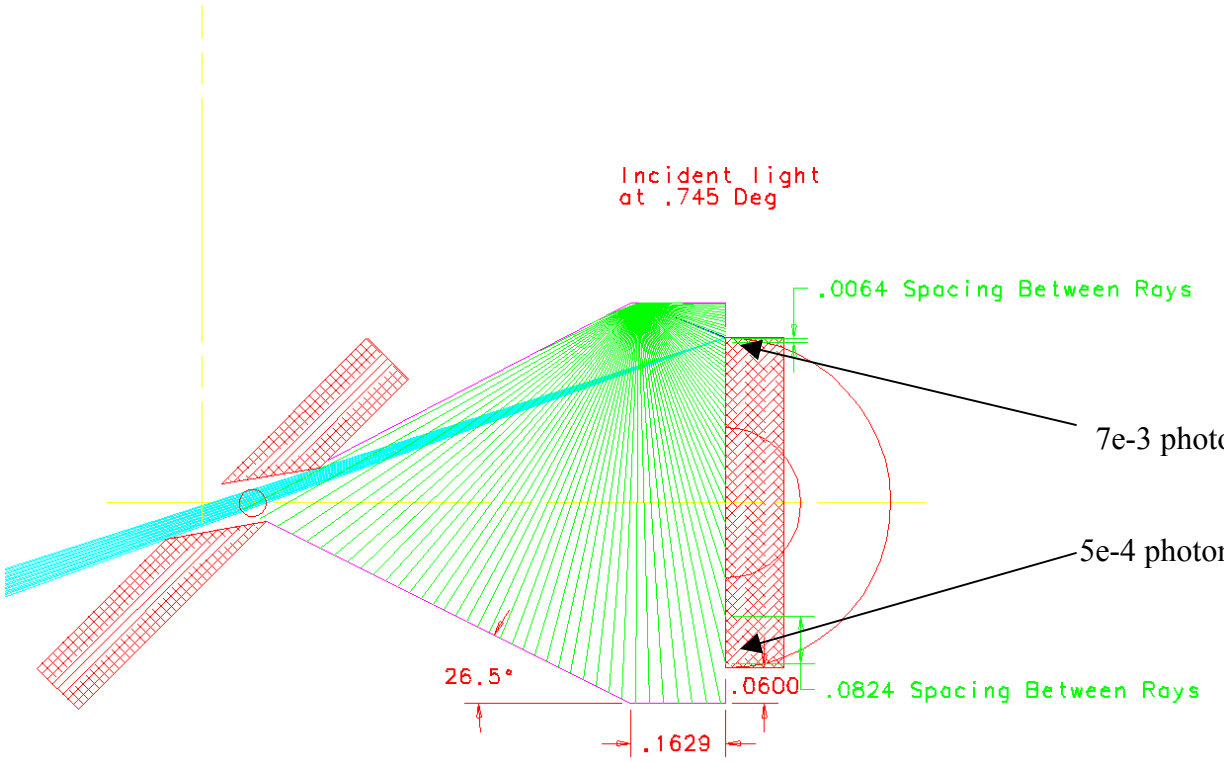
Worst case M8 star hitting near edge

Distance from focal plane to shield

=0.06 meters

4x less intensity than cone

Ray Tracing of Light Hitting Church Shape Shield



Worst case M8 star hitting near edge

Distance from focal plane to shield

=0.16 meters

28x less intensity than cone

CONCLUSIONS

1) Using a white diffuse coating results in back scattered light intensities on the focal plane of the same order magnitude as Zodiac

2) Using a black coating further reduces intensities by a factor of ~100 or more

3) Different shield geometries may further reduce the intensity by a factor of 30, and make a more uniform profile.

4) Mike Sholl is running ASAP models and will have detailed results; Fermi will use the crude ray tracing models to give a reality check for the ASAP results.

5) Optical and Mechanical Shield Coating Testing is not needed,

   a) Black coatings create back scattering well bellow Zodiacal in the Super Nova field

   b) Mechanical properties of Coatings like Martin Black are well documented and referenced

The next step:

Coating issues and shield material issues are nearly solved. Next up is adapting the shield mechanical model to interface with the focal plane, mounts, thermal straps, and the shutter. A draftsman has been assigned to the Solid Works software and will start next week.